

Future Collider Activities in Australia

Ulrik Egede and Paul Jackson

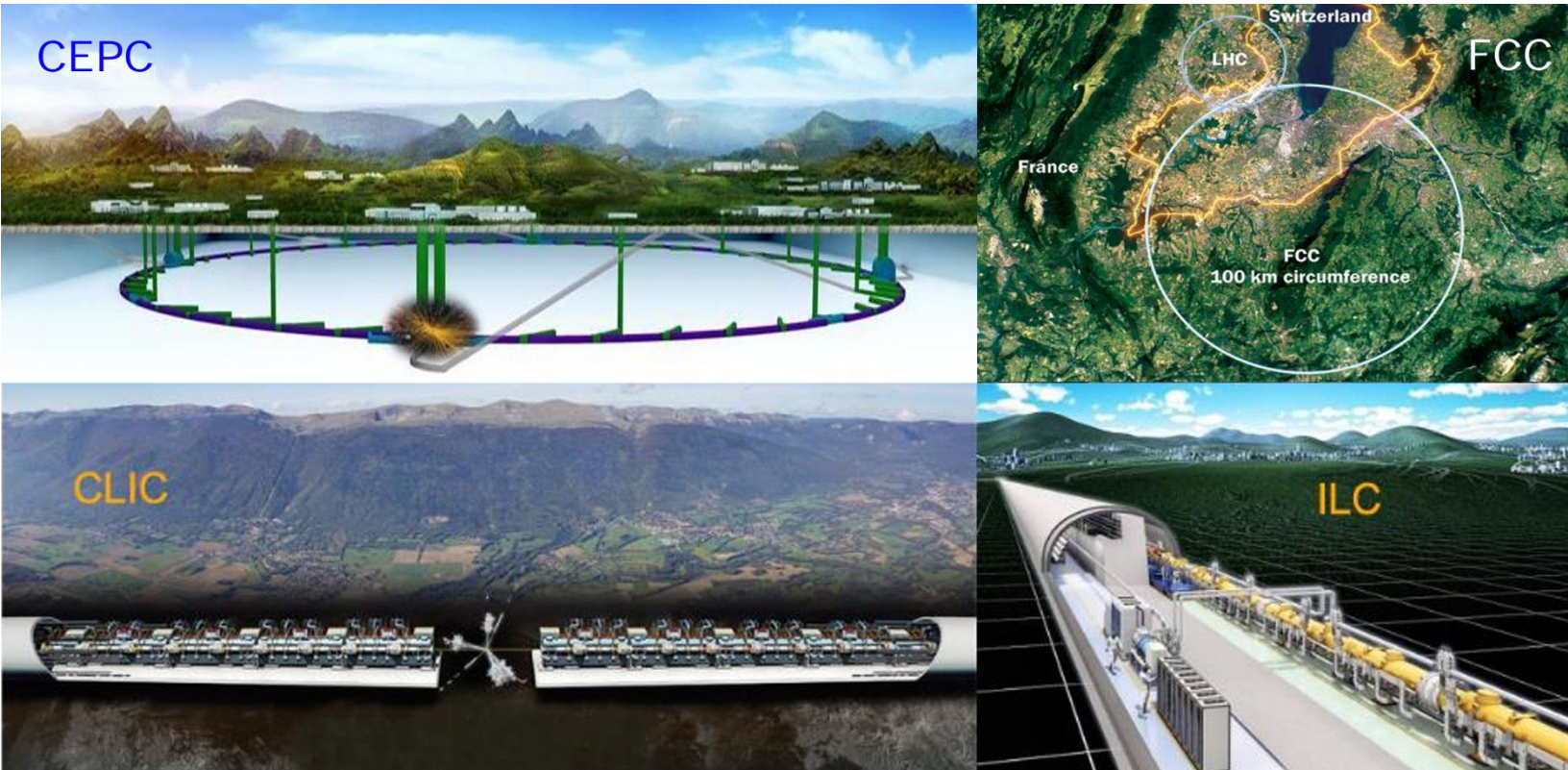
December 3rd, 2024

Introduction

We have a modest, but strong, collider particle physics community in Australia.

We're eager to grow and remain active in large scale projects across the community/globe.

The next generation particle collider is likely to be an e^+e^- "Higgs factory" with several proposals



Possible future main facilities

Foreseen to start operations within the coming 10-20 years (or so):

CEPC (China)

FCC-ee (Europe/CERN)

ILC/CLIC (Japan)

EiC (USA, approved)

CCC (USA?)

Beyond 2045, there are other potential options (these are contingent on the earlier facilities going ahead):

FCC-hh, SppC, Muon Collider

**None of these facilities rely on Australian participation,
nor are we beholden/committed to any of them**

2020 Update of the European Strategy for Particle Physics

There are compelling scientific arguments for a new electron-positron collider.

The vision is to prepare a Higgs factory followed by a future hadron collider.

Investigate the feasibility of a future hadron collider at CERN with a centre-of-mass energy of at least 100 TeV and with an electron-positron Higgs and electroweak factory as a possible first stage.

Ramp up R&D effort focused on advanced accelerator technologies.

2020 UPDATE OF THE EUROPEAN STRATEGY
FOR PARTICLE PHYSICS

by the European Strategy Group



2023 Particle Physics Project Prioritization Plan (P5)

Plan and start an off-shore Higgs factory, realized in collaboration with international partners.

The current designs of FCC-ee and ILC meet our scientific requirements.

Targeted collider R&D to establish the feasibility of a 10 TeV pCM muon collider is recommended.

Expand the General Accelerator R&D (GARD) program within HEP.



Let's briefly consider the current leading proposal from CERN: FCC (ee/hh)

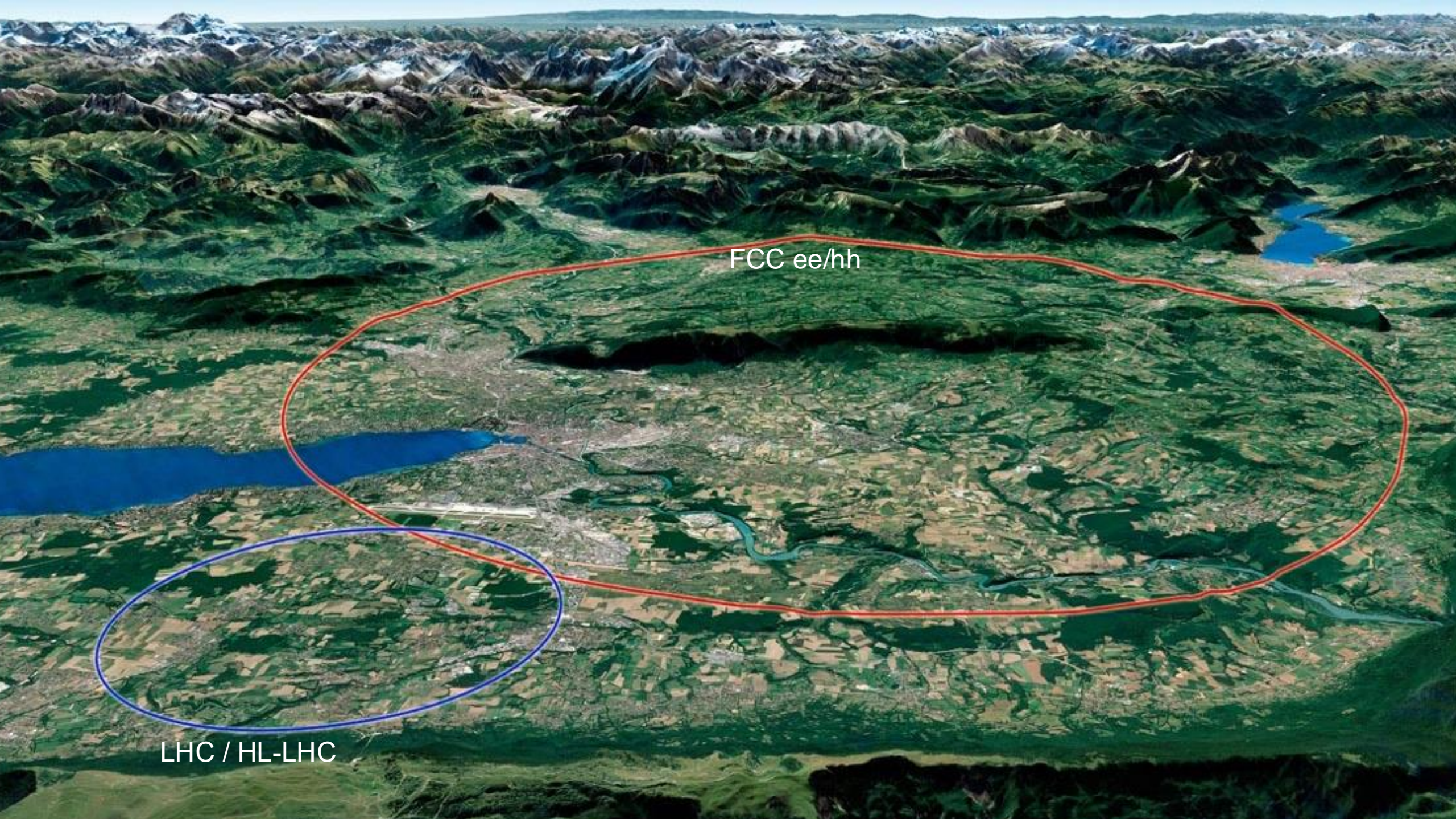
FCC: A comprehensive long-term programme

Maximising physics opportunities:

- Stage 1: **FCC-ee** (Z, W, H, $t\bar{t}$) as a **Higgs factory**, electroweak & top factory at highest luminosities
- Stage 2: **FCC-hh** (~100 TeV) as natural continuation at energy frontier, **proton-proton** with options



- The program is highly synergetic and complementary **enhancing the physics potential of both colliders**
- **Common civil engineering** and technical infrastructures, building on and reusing CERN's existing infrastructure
- FCC integrated project **allows the development of a significant new facility at CERN**, within a few years of the completion of the HL-LHC physics programme



FCC ee/hh

LHC / HL-LHC

CEPC



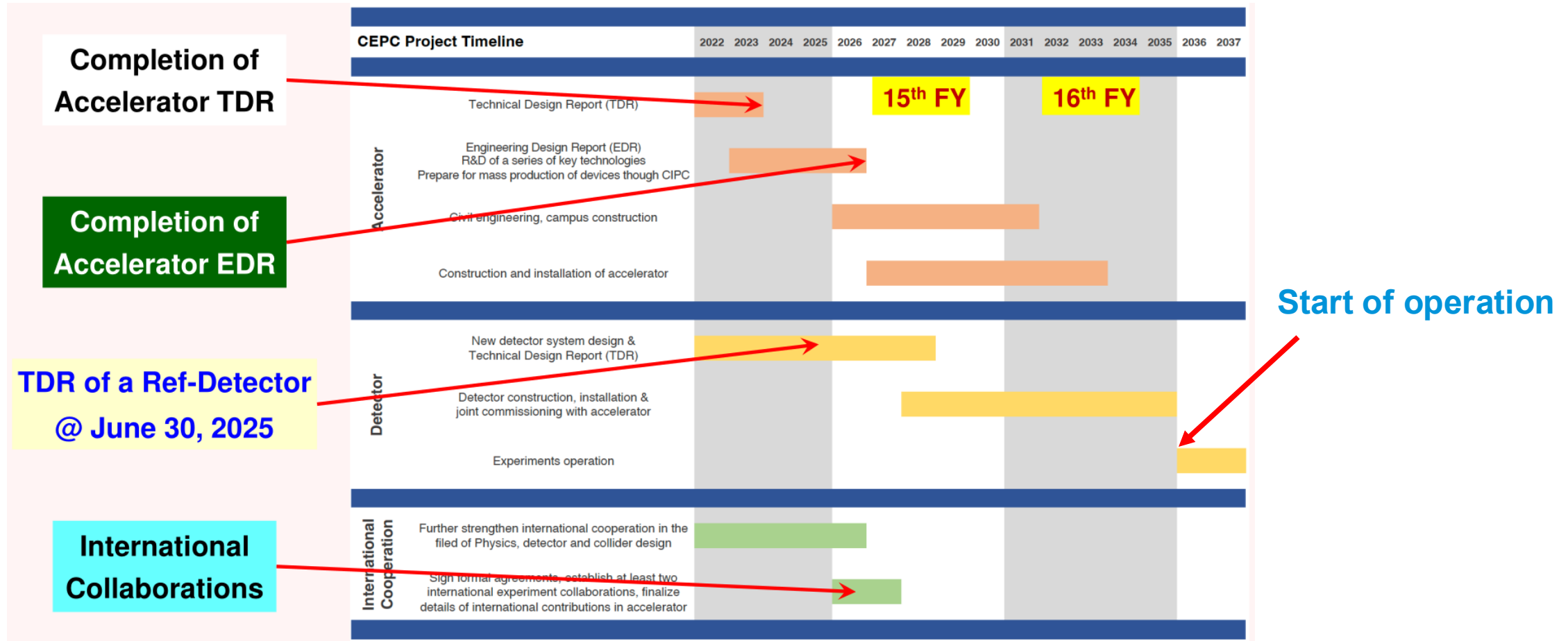
Let's briefly consider the current leading proposal from China: CEPC

CEPC

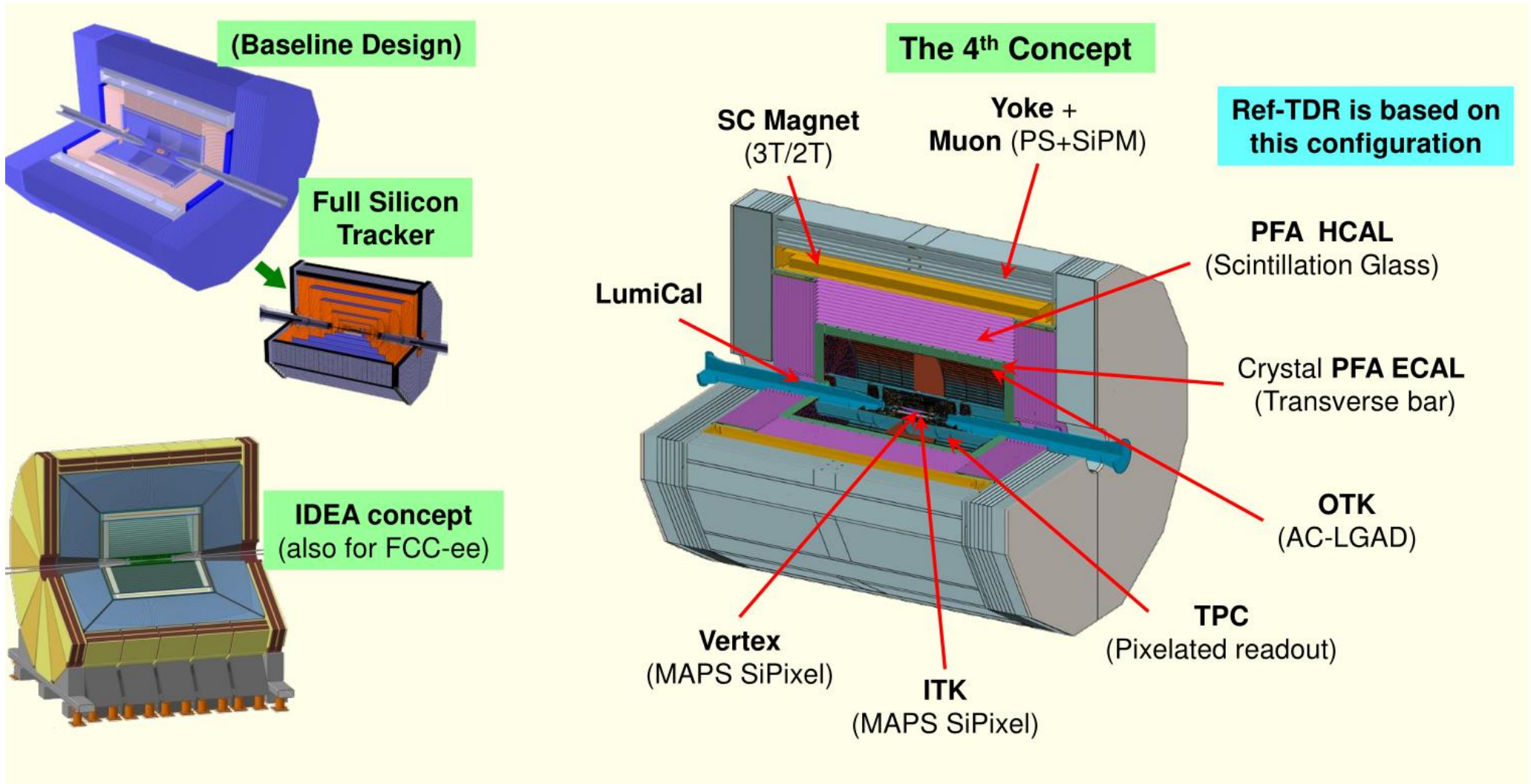
- **Very similar in design parameters to FCC-ee**
- **Multiple sites under consideration**
 - Local government support
 - Geology
 - Energy supply
- **Collider**
 - Almost exclusively a Chinese project
- **Detectors**
 - A conceptual design at the moment
 - Two fully international collaborations expected to build detectors



CEPC: The optimistic timeline



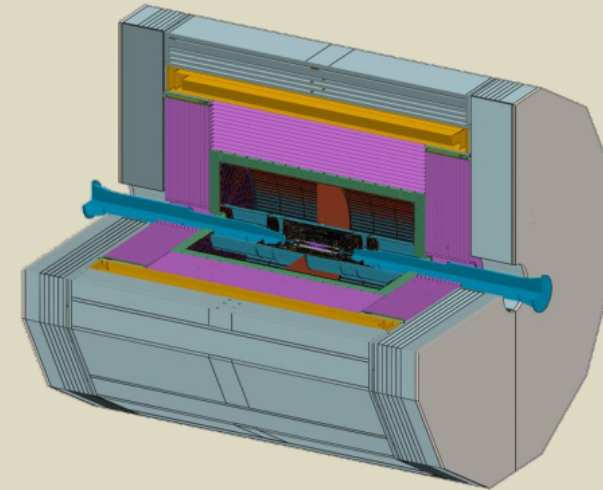
Reference detector concepts



CEPC detector technology

System	Technologies	
	Baseline	Backup / Comparison
Beam pipe	Φ20 mm	
LumiCal	SiTrk + Crystal	
Vertex	CMOS + Stitching	CMOS Si Pixel
Tracker	CMOS Si Pixel ITK	SSD + RO Chip, CMOS SSD
	Pixelated TPC	PID Drift Chamber
	AC-LGAD OTK	SSD / SPD OTK
		LGAD ToF
ECAL	4D Crystal Bar	Stereo Crystal Bar, GS+SiPM, PS+SiPM+W, SiDet+W
HCAL	GS+SiPM+Fe	PS+SiPM+Fe, RPC+Fe
Magnet	LTS	HTS
Muon	PS bar+SiPM	RPC
TDAQ	Conventional	Software Trigger
BE electr.	Common	Independent

- The CEPC study group started to compare different technologies in January, 2024
- By the end of June, 2024 the baseline technologies were chosen.
- Multiple factors were considered in the process: performance, cost, R&D efforts, technology maturity, ...



- We will continue pursuing better technologies for the two final detectors at CEPC

Open questions for the Australian Community

What physics are we interested in pursuing?

What facilities are we (not) interested in participating in?

What detector/accelerator technologies and equipment are we interested in working on? Do we want to build in Australia? If so, what?

Open questions for the Australian Community

What are our collective goals/ambitions?

When should we aim to commit?

What funding avenues should we consider?

Short-term (<5 years); Medium term (<10 years); Long term (10+ years)

Open questions for the Australian Community

What next?

Next update of the European Strategy for Particle Physics (ESPP)

- **The ESG (chaired by Karl Jacobs) is mandated to take into consideration:**
 - The input of the particle physics community;
 - The implementation of the 2020 Strategy update;
 - The accomplishments in recent years, including results from the LHC and other experiments/facilities worldwide, progress in the construction of the High-Luminosity LHC, the FCC Feasibility Study, and recent technological developments in accelerator, detectors and computing;
 - The international landscape

Timeline for the update of the European Strategy for Particle Physics



Input for European Strategy for Particle Physics

- **A major component of this overall input are the national inputs, which will be collected individually by each country (and in some cases by regions).**
 - The information collected from the different countries will be most useful in informing the ESPP process if it is as coherent and as uniform as possible, when addressing the key issues.
 - To assist with this, ECFA has put together a set of guidelines for the collection of the national inputs.
- **It is suggested that two national ("town-hall" or similar) meetings be organised**
 - one meeting between the end of March 2025 and the deadline of 26 May, and
 - a second one after the release of the Briefing Book, around the end of September 2025, before the deadline of 14 Nov 2025
 - The meeting(s) should be guided by a set of “standard questions” to be considered